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Low cost as well as timely statistics are required of University policy planning decisions regarding student housing. Since a data bank already existed at the University of Wisconsin, a study of student housing needs could readily be undertaken by means of a computer. The study defines the status of the existing supply and demand in student housing in order to measure the significance of changes occurring over time in the past or to be expected in the future. With data gathered, solutions regarding student housing policy become more evident. Information can be used in estimating the demand for particular types of housing as well as for showing trends in student residence locations. An essential question is the degree to which private investment can be expected to supply the shortage areas given the relationship between rent paying ability of the students and the profit opportunities for the investor. One preliminary result of the study is the selection of a reasonable construction plan, rent schedule, and investment value for each class of site if it were purchased at an estimated acquisition value. (NI)

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COMPUTER PROGRAMS FOR PREDICTING PRIVATE DEVELOPMENT OF STUDENT HOUSING FACILITIES

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I

INTRODUCTION

A. The Problem

The problem of housing a variety of students in a manner which fits their budget, style of living, and choice of compatriots is well suited to the land economist, both as basic research and as a service to his University. The student housing problem can be one of those rare studies in economics in which most all of the potential customers can be identified by name and supply units can be physically counted, both existing and potential units. University records identify those in the market, trace their housing preferences through time, and give access to a wide range of relevant information about the customer. University records can also identify the character of supply with useful detail. Thus study begins with a somewhat artifically structured, closed market system for which there can be complete supply and historical demand data and for which there are a variety of short and long term forecasts as to number and type of consumers. Indeed the problem is too much information and without mechanical methods of analysis and organization it is often impossible to research the data while it is still current and relevant to University planning and policy decisions. Nevertheless the University must anticipate

the impact of a change in the total enrollment, a shift in enrollment distribution, a change in student housing rules or an addition to student housing investment on the individual investor, neighborhood, or community.

B. The Research Base

Low cost as well as timely statistics are required of University policy planning decisions and low cost requires that the data base exist in part on cards, that electronic data processing programs already be operational, and that personnel with interest and ability be willing to accept workable solutions rather than theoretical perfection. Housing location and type has been an input on the registration of all 33,000 students at the University of Wisconsin Madison campus for the past three years and the University Housing Bureau has been cataloging the student housing supply for several years prior to that - thus the base of a data bank existed. The thrust of this essay will be on the computer program already in existence as a by-product of the research in the real estate department in the School of Business. However, willingness of the University departments for planning and for student housing to experiment with EDP was in good measure due to the confidence which these departments had in Richard Garrigan, a Ph.D. candidate in land economics, the instructor in our basic land economics course and the real estate analyst for campus planning. This report represents a journalistic survey of the present projects related to real estate analysis via the computer rather than an explanation in depth of any single program.

II

Organization of the Research Approach

The data available and the processing program operational seemed appropriate to a comprehensive supply and demand analysis of the student housing market. The hope was to define the status of existing suuply

and demand in order to measure the significance of changes occurring over time in the past or to be expected in the future.

A. Supply Statistics

1. There was a physical inventory of housing units, which was begun as part of approved University housing program and later extended as part of a certified housing program. Within a mile of the University the number, capacity, and condition of all student rooms and private dormitory space was inspected and cataloged. This inventory did not originally include full scale apartment units, an omission which is gradually being corrected from Madison Building Department records.
2. There was an inventory of University operated student dormitories and a large group of privately owned, major dormitory buildings which participated in various joint advertising programs with the University.
3. Building permit information and the annual mapping of actual student addresses revealed student penetration into predominately single family areas for identification of newly available supply units.

Consideration of future private construction of student housing and the constraints to such construction was therefore the missing component to further analysis of the supply sunction.

B. Demand Statistics

1. For the past three years student housing locations as reported in registration material has been mapped for the Core Area of Madison relative to the campus block by block and for the non-Core metropolitan area by zone. The statement of purpose for this study as published each year suggests the multiple uses of that data: (1)

> With the data that has been gathered, solutions regarding student parking and student housing policy become more evident. The information contained in this report can also be used in estimating the demand for particular types of housing such as graduate and professional

(1) Department of Planning and Construction, STUDENT RESIDENCE LOCATION STUDY MADISON CAMPUS, 1966 - 67

student housing. Further, with the data available, evaluations can be made regarding the number of students to be moved if an area is to be acquired for building expansion. Of considerable significance is the use of the comparative data for showing trends in student residence location tendencies.

Students have been classified according to sex, marital status, student classification, and residence status, information which provided the base for a stratified sample for an additional questionnaire. In addition the undergraduate group can be identified by class year or as a special student.

From this study it was possible to establish that the Core Area, basically one mile from the center of campus defined as Bascom Hall, contained 22,363 students, 71.5% of the total number of enrolled students. This number represented a numerical increase of 635 students over the previous year 1965 but a decline of 2.6% in all students. Most of the increase was represented by single females (2) while married students showed a relative and absolute decline. The studies further indicated that resident graduate students were leading the outward migration from the Core Area. These statistics are suggested only as examples of trends revealed by aggregation of registration cards and mapping of much of the data by blocks. (3) It follows that significant trends deserve further inquiry as to why various segments of the student body are choosing the accomodations that they do and how well satisfied with their choice they are.

2. To add a quality dimension to the quantified demand data described above it was then desirable to do a housing preference study and to identify the constraints on choice affecting the student decision making process. A comprehensive student survey questionnaire was

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(2) This group consistently locates 95% of its numbers within walking distance of campus so that any increase in their number anticipated by University plans must be absorbed by the Core Area, an example of how registration data provides coefficient for forecasting housing demand.

(3) The City Planning Department is also using the data to forecast the need for additional utilities, parking, and other problems related to high density housing.

prepared and distributed to a stratified sample of 1,000 students which could be divided by private-public housing, single-married, resident--non-resident, graduate-undergraduate, and male-female, a possibility of 32 various sub-sections.(4) These materials were prepared as a project of the Wisconsin Survey Research Laboratory under the direction of Professor Harry Sharp. The questionnaire tested the respondent satisfaction with a variety of specific aspects of his unique problem solution, including cost, spaciousness, privacy, sound-proofing, neighborhood, traffic, parking for autos, convenience to University, and so on. There were further questions on the information media and decision making process by which the student made a housing choice for the semester. Then there were questions as to future area preferences, pinpointed by numbered maps, expected housing budget for the following semester, and the type of unit that would be sought. Finally the questionnaire probed at the rent paying capacity of the student or his family and his general means of support.

A comparison of demand as mapped relative to preferences revealed by the survey is therefore the next step in analysis of the various requirements and dissatisfactions of the demand function.

III

Forecasting Demand Parameters By Computer

The housing quantity and quality preference studies should produce some definite statements as to preferred locations and preferred characteristics of housing units for a large variety of sub-market groups within the student body. The existing catalog of housing, at least in the Core Area and implemented by 1970 census material should suggest the degree of over-supply or shortages relative to each sub-market identified in the demand study.

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(4) 831 completed questionnaires provided sufficient responses in 30 of 32 sub-classifications.

A. Policy and Investment Incentives

The essential question then becomes the degree to which private investment can be expected to supply the shortage areas given the relationship between rent paying ability of the students and the cost and profit opportunities for the investor in preferred locations. To the degree that the student housing market does not provide sufficient profit incentive to build housing adequate to meet projected enrollment in the 70's, the University will need to subsidize private development or undertake further development on its own. Either course of action has its pitfalls. Public subsidies such as tax relief for urban renewal were found to be discriminatory by the Wisconsin Supreme Court, while apartment construction by the University has generally been considered to be too competitive with private enterprise by the legislature. One byproduct of forecasting supply and demand analysis must therefore be facts which will either refute the courts or convince the legislature as to the justification of any University housing action. With 70% of students housed in privately operated facilities, even the Regents of the University must be sensitive to implications of their decisions relative to incentives for continued private investment in student housing.

B. Policy and Research Priorities

The volume of information on the quality of demand in response to the survey questionnaire is now being processed with a priority reflecting current University problems. The University has had a substantial program for married students and a good demand for college operated dorms, but a recent change in housing policy for undergraduates has caused some significant dislocation of single students. A year ago the University released all students from housing control except for freshman men and freshman and sophomore women who must live in supervised housing. Junior men and women and sophomore men under 21 may live in non-supervised housing with permission of their parents, and all others have unqualified choice.(5) The result

(5) At this time complete removal of all restrictions is being contemplated which has created serious disruptions in spring leasing programs for private operators.

was to make roughly 9,000 more students eligible for apartment living, and a significant majority of these filled apartments to relieve what had been an over-built market. At the same time the exodus from private, dormitory style high-rise units put at least two large, private dormitory projects in a position of having to convert to office rental. (6) Garden apartments in the suburbs were preferred to high-rise types closer to campus, in part because they were more humane in scale and in part because they were more reasonable in price. Apartments near campus have assumed each resident could afford about $70 a month so that a basic, furnished two-bedroom apartment for four students commands $280 a month, and indications from early filings with the housing bureau are for $300 per month in the 1968 semester. Thus it was decided that three of the available graduate students in real estate would examine the market preferences and supply constraints for apartments in the student Core Area.

Market preference studies have been undertaken by two of the students for the eight classifications of single students - resident--non-resident, graduate-undergraduate, male-female. The response of each sub-class to each question was tested relative to the entire sample by means of a comprehensive chi-square test program developed for the 1604 computer by the Survey Research Lab. This test has pinpointed the significant differences in preference patterns for each basic segment in the market. While an infinite number of cross-correlation runs could be made, the cost of the 1604 computer required selected cross-correlation studies based on common sense and a visual review of the data. With the completion of this study in June it should be possible to state with statistical reliability the distribution of preferences for location, housing style, and amenities at given rent levels for various sub-groups in the student body.

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(6) These projects were built for a market controlled by University housing regulations, partly in response to University pleas for more student housing. Within two years after their completion, the University approved a change in housing rules.

C. Projection of Demand

The pattern of distribution provides ratios which can be applied to enrollment figures for each sub-group in the student body to estimate housing needs for existing or projected enrollments. A 10% increase in the total enrollment will affect the demand for particular types of housing units in many different ways, depending on how the total increase is distributed among the student types. If the increase were all in the graduate school, pressure on the campus Core Area would be much less as the majority of the graduate students are married and look for housing in peripheral zones in Madison. The impact on Core housing would be quite different if most of the increase could be attributed to junior and senior students transferring to Madison from University centers around the state. Undergraduate single students explain much of the pressure for apartments within walking distance of the University. Given enrollment expectations it is possible to indicate the location and housing type features which will be in demand. If this demand reveals a shortage compared to the certified housing inventory in the Core, then it is necessary to examine the probability that private investment will supply the unmet needs by replacement of obsolete low density standing stock with more modern, intense developments. The objective of these studies is to provide a well targeted, "rifled" market analysis for many specialty units rather than "shotgun" aggregate statistics. The secondary data found in much that is done for feasibility analysis is useless for establishing effective unit demand and the compatibility of various sectors in the apartment market.

IV

Forecasting Supply Parameters By Computer

The potential number of apartment units which could be supplied in the Core Area would naturally be a function of available sites, the

density of development permissible under city zoning controls, the rent paying power of the various sub-sectors of the student market, and revenue-cost ratios of alternative building types and rental unit mixes. To solve these complex equations of dynamic interrelationships, two computer programs developed by the School of Business Real Estate Department were selected. The first program was designed to forecast acquisition cost of multiple parcel sites with the aid of multiple regression analysis of appropriate sales prices. The second program, a hueristic dynamic investment model, combined a capital budgeting and finance model, an operating revenue and expense model, an internal cash flow after-tax model, and income appraisal model to determine land residual values under any type of rental real estate.

A. Supply and Investment Analysis

The designing of the research project began with the simple assumption that if the acquisition cost of the site were known, the developer would tend to build that type of apartment building which would maximize both the dollar rate and the yield rate of return to equity after taxes. It would follow that if the various types of real estate were analyzed as to the best profit improvement which might be placed upon them, an idea would be gained of the total number of units which might be produced on available sites at given land, construction, operating cost levels and given student powers to pay the rent. Such analysis should produce a good estimate of the maximum that might be built, and the maximum could be modified by a ratio reflecting cumulative construction over time. Then the adequacy of supply, including existing stock and anticipated new units, could be compared to unit demand as suggested by the survey questionnaire and enrollment projections.

B. Predicting Land Acquisition Costs

The University of Wisconsin regression model for estimating acquisition costs for budget purposes of multiple parcel sites has been well described in an article headlined by a journalist, not a land economist, as "You Can Accurately Predict Land Acquisition Costs" by our associate Richard Garrigan.(7) His research correlated the land acquisition costs of 108 properties acquired by the University during a three year period between Jan. 1, 1963 and Dec. 31, 1965 with (1) the assessed value of the land; (2) the assessed value of the improvements; (3) the area of the land in square feet; and (4) a factor representing the time in months which had elapsed between January 1, 1963, and the acquisition. A remarkable correlation coefficient of .97 was achieved and when tested for 33 properties acquired in 1966, the correlation fromula produced an assembly cost only 2% higher than the actual cost of acquisition for the University. More recent sales have been continually added to the coefficient components in the formula and the method is being used to predict land acquisition budgets for the University biennial budget.

With this model in mind the appropriate data for all tax parcels in the 300 block area of the student Core zoned for multi-family residential was put on cards for the computer. The computer was then programmed to estimate the acquisition costs on every parcel in terms of cost per square foot of land. The parcels in each block were then cataloged and mapped according to classification as a $5, $6, $7, $8, and $10 per square foot parcel. The mapping permitted identification of various parcel assemblages in each block which would be possible at each price group and those which would not be available at all, presumably because they were already intensely developed. The original inputs were largely 1962 assessments, and many of the cheapest sites according to the computer

(7) Garrigan, Richard, College & University Business, August, 67, Vol. 43 #2, p. 35 & 36

valuation method were shown in review to have been those developed first. This tendency seemed to vindicate the assumption that private redevelopment of the student housing area was a function of profitability and that a major constraint on profitability was land cost. Data inputs were then updated and expanded to reflect several minor changes in zoning and reassessment by the city of Madison.

On a tax parcel map of the entire high density housing area within the University Core, estimated costs for each parcel were coded in color according to price groups mentioned earlier. Each parcel was further identified as to whether it was already part of an assemblage and in strong hands or was apparently independent of any known developer. These maps for these parcels were further outlined according to certain zoning bonuses and constraints in operation in Madison high density housing areas. The result of the computer runs and the mapping was the identification of the number of parcels available at each selected price per square foot according to four sizes of lots and three sub-classifications within existing zoning laws. It is interesting to note that the total cost of this effort in cash outlay was about $300 for coding the parcel information and about $600 as part of a research assistantship to the graduate student who is building his masters' thesis around this project. The computer time was accounted for both as part of the budget of the University Planning Department and as the free time available on the Business School computer for graduate students doing research.

C. Predicting Probable New Construction Characteristics

The second part of this project was to test each site class by size, cost, and zoning constraints to determine the optimal number which could be built on each site type. The forecast of supply would then achieved by the product of the number of sites in each class, the unmber of units

most appropriate for each site, and the cumulative percentage of development assumed at any given point in time. The rate of development would be highly sensitive to profitability but nothing more than pragmatic assumptions for high and low estimates of actual building rates are being used at this time.

The dynamics of the real estate investment model which determines the optimal number of apartment units to be constructed can only be briefly summarized at this point. The student designed a masonry, load bearing construction module with plans for an efficiency unit, a one-bedroom unit and a two-bedroom unit. In addition he designed a corridor module and a stairway module. In addition he included certain optional costs for large or small kitchens, private and semi-private baths, and furnishing packages, all based on Madison construction experience and time adjustment factors for 1970 construction. These building blocks were combined into various construction alternatives for each standard site classified by size, zoning, and land coverage options under the zoning law. Similarly representive rental schedules, operating costs, and financing terms were established for developers in the Madison area.

D. The Investment Model

The Wisconsin real estate investment model is a major subject in itself and so it is summarized in Chart I and the following short paragraphs at risk of losing much in translation.

The basic structural concept of the model is to permit the analyst to define building blocks with which he can create alternative combinations of cost, operating characteristics, financial packages, and related cash flow dimensions. The basic building block is a component called a FEATURE, which can be given any kind of unit description, such as a square foot of area, a parking stall, a floor type, or even an entire building structure. The quantity of features used to describe any one project can be either

varied or constant. VARIABLE FEATURES are combined into revenue generating elements, such as a one bedroom unit, or motel room, or office building floor. There may be different numbers of RENTAL ELEMENTS in a rental class, ranging from one element defined as a package of one site/one building to a rental mix of as many as 9 fifferent types of apartment elements in different quantities in the same building. Rental elements not only have quantity and cost dimensions but a revenue and expense dimension as well. Aggregate quantities and cost determinations by the computer determine budget, capital structure and various measures of design efficiency. Aggregate revenue and expense calculations by the computer provide a basis for income, expense, and cash flow analysis as will be illustrated in detail in following sections. Period cash flow to the investor is then a basis for investment valuation.

A simplified flow chart is given in Chart I to suggest the type of outputs which can be generated if full details are available. However it should be emphasized that it is possible to generate valuable information from the sketchiest data. For example, a simple allocation of an offering price between building, equipment, and land where annual rent and expense ratios are known can produce a significant answer, although much additional marginal analysis of useable area efficiency, rental mix, or accounting accuracy will not be available for lack of required input. As frequently as disired by the analyst, the model will then appraise period cash income and resale values by means of three different value approaches which can be classified as traditional, mortgage-equity and after-tax methods. Both the property residual and land residual values for all three approaches at seven different discount rates are given to facilitate comparison of results and decisions on the range of returns to be expected.

The model may be termed hueristic, for it runs through a single set

of inputs and stops without searching for an optimal solution. Since the combination of alternative inputs is infinite, it is presumed that the analyst has narrowed his choices to a limited set of practical alternatives on the basis of his own judgment and experience. The product of the model is an extension of decisions already made or modified as a result of previous runs on the computer. It lacks the glamour of an optimizing model or decision making model, but it is doubtful that the art of real estate investment can either be made conclusively mechanistic or could be accepted as such by practitioners if it were. Any model builder must anticipate the resentment any computer system generates among real estate practitioners, and this model deliberately avoids infringing on matters of "judgment".

E. Some Preliminary Results

The net product of over 100 runs of the model was the selection of a reasonable construction plan, rent schedule, and investment value for each class of site if it were purchased at the estimated acquisition value. Conservatively financed at 75% of total capital cost with 7%, 25-year mortgages the after-tax rate of return on different types of buildings ranged from 10 to 14% including capital gain on resale in the 3rd, 6th or 9th years of operation. This rate of return did not seem so impressive that developers would rush to build for students unless rents were higher than $70 per man per month, high ratio financing were consistently available or land costs could be reduced, particularly costs above $7 a square foot. The graduate student is now testing the implications of changes in each of these three critical variables on profitability. It would appear at this report that the most likely assistance to yield to equity would be higher loan ratios and higher rents, the logical result of a free market adjustment. However the student is also testing the possibility of University owned land leased

to the developer or government financing with a 40-year term at less than market rates of interest with rents held at present levels. A byproduct of this study of investment dynamics will include a measure of the effectiveness of incentives in zoning options whereby the investor can trade off ground coverage, parking requirements and even his alternatives in regard to tenant selection for additional units for revenue, probably at some additional cost in construction for multiple story development.

V.

Conclusion

With these broad strokes of the brush, a picture should hopefully emerge of the many uses for the computer in developing supply and demand functions for student housing. Its ability to rapidly process information permits maintenance of an inventory of student housing units. Its role in registration can provide byproduct data on student housing locations by block, type of accomodations, and type of student. Survey research techniques with the computer can permit comprehensive analysis of consumer preference surveys to discover unmet needs and shifting patterns of housing preferences by significant sub-markets within the student body. Dynamic models of appraisal and investment will suggest opportunities and then shape participation for private investors in student housing needs. Indeed computer models may assist in development and illustration of improved methods of zoning, financing, or ownership forms which can provide greater incentive to private business and relief on University resources in matters of student housing.

CHART I

SIMPLIFIED FLOW CHART
OF
WISCONSIN REAL ESTATE INVESTMENT SIMULATION MODEL

INITIAL DATA INPUTS

1. feature unit cost
2. quantities of features in each rental class
3. rent, expense, and occupancy factors
4. indirect capital costs
5. capital financing schedule
6. capital depreciation schedule
7. time index adjustment factors
8. real estate and income tax data
9. appraisal and yield data

PHYSICAL IMPROVEMENT DATA PRINTOUTS

Total Quantity and Cost of Component Features

Feature Quantities and Costs of Rental Element Types

Indirect Capital Costs

Total Capital Finance Plan

Capital Depreciation Plan

Key Financial Structure Ratios

Key Physical Improvement Ratios

Simple Marginal Analysis Comparisons of Rental Mix

CASH FLOW DATA PRINTOUTS

Standard Income and Expense Statement

After Tax Cash Flow Statement

Net Worth Summary

Standard Financial Ratios

Current and Cumulative Yield Comparisons

INCOME APPRAISAL & YIELD PRINTOUTS

Summary of Capital Investment, Mortgage and Land Cost Data

Present Value of Income and Reversion Before Recapture or Financing at 7 Discount Rates Selected By Investor

Present Value of Income and Reversion With Consideration of Debt Service But Before Taxes at 7 Discount Rates Selected By Investor

Present Value of Income and Reversion After Allowance For Debt Service and Income Taxes at 7 Discount Rate Selected by Investor

Land Residual Value For Site Using Each of 3 Approaches to Property Residual Value at 7 Discount Rates